Eight Year Climatologies from Observational (AIRS) and Model (MERRA) data

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Abstract

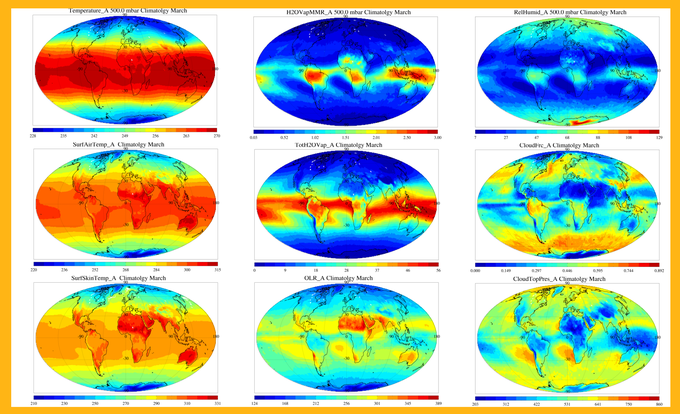
We examine climatologies derived from eight years of temperature, water vapor, cloud, and trace gas observations made by the Atmospheric Infrared Sounder (AIRS) instrument flying on the Aqua satellite and compare them to similar climatologies constructed with data from a global assimilation model, the Modern Era Retrospective-Analysis for Research and Applications (MERRA). We use the AIRS climatologies to examine anomalies and trends in the AIRS data record.

Since sampling can be an issue for infrared satellites in low earth orbit, we also use the MERRA data to examine the AIRS sampling biases. By sampling the MERRA data at the AIRS space-time locations both with and without the AIRS quality control we estimate the sampling bias of the AIRS climatology and the atmospheric conditions where AIRS has a lower sampling rate. While the AIRS temperature and water vapor sampling biases are small at low latitudes, they can be more than a few degrees in temperature or 10 percent in water vapor at higher latitudes. The largest sampling biases are over desert.

The AIRS and MERRA data are available from the Goddard Earth Sciences Data and Information Services Center (GES DISC). The AIRS climatologies we used are available for analysis with the GIOVANNI data exploration tool. (see, http://disc.gsfc.nasa.gov)

Eight Year Climatologies from AIRS

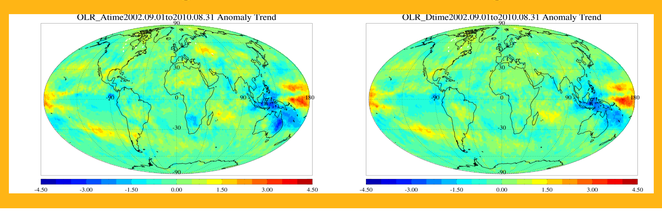
We show the 8 year climatologies from AIRS examined in this study for the Ascending (daytime) parts of the AIRS orbit for the month of March.



OLR Trends

The OLR in the tropical western pacific has shown both positive and negative trends over the course of the AIRS mission. Susskind et al. (A43B-0202) have used AIRS observations to show that this can be explained by changes in watervapor and clouds.

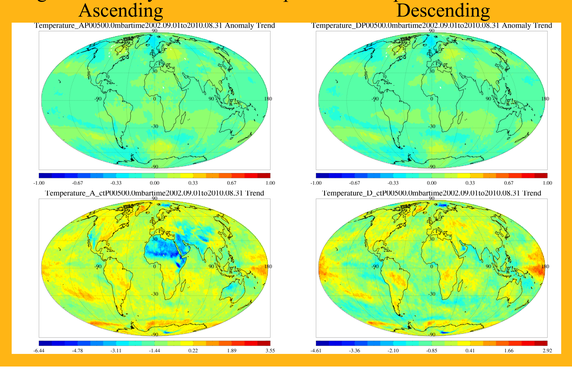
Ascending Descending



Temperature at 500 mbar

Although there is not much of a trend in the Temperature at 500 mbar there is a decreasing trend in the yield (the number of AIRS observations included in the sample) over desert in the ascending part of the orbit and an increasing trend in the yield over the tropical western pacific.

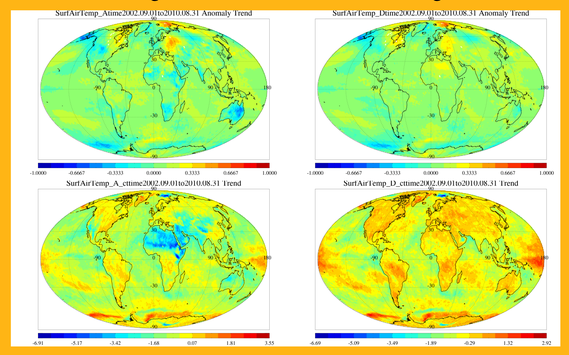
Ascending Descending



Surface Air Temperature

The Surface Air Temperature shows similar changes in yield as those seen at 500 mbar.

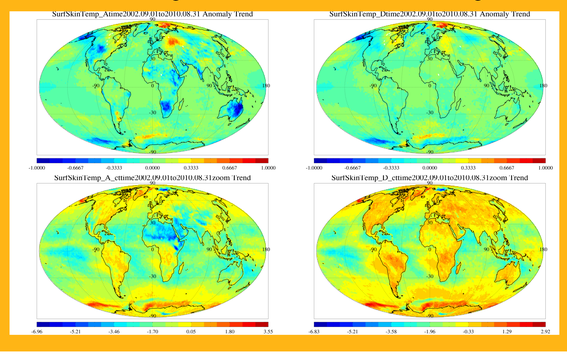
Ascending Descending



Surface Skin Temperature

The Surface Skin Temperature shows larger trends in the daytime than at night. The temperature and yield trends around Antarctica may be due to changes in sea ice.

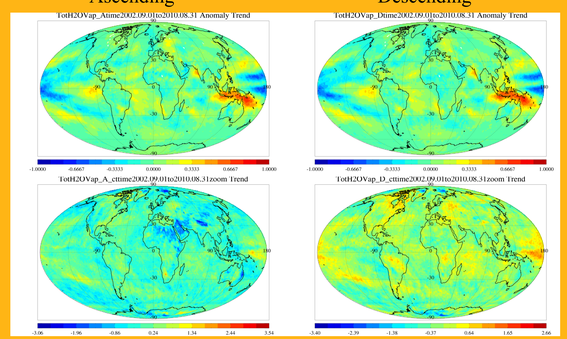
Ascending Descending



TotH2OVap

The total water vapor anomaly trend is strongly anticorrelated with changes in the OLR.

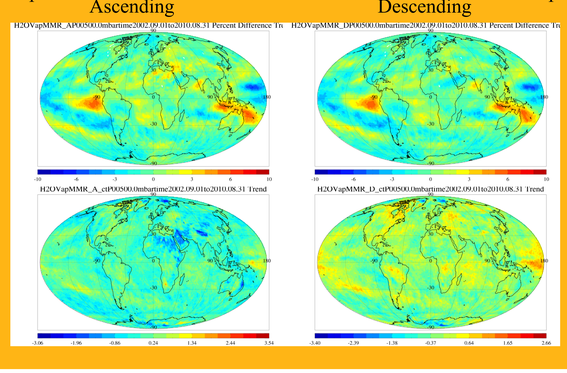
Ascending Descending



H2OVapMMR at 500 mbar

The Water Vapor Trends at 500 mbar are similar that seen for the total water vapor.

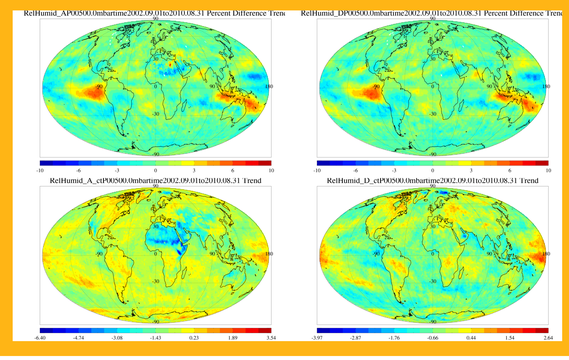
Ascending Descending



Relative Humidity

The relative humidity trends at 500 mbar are similar to the mixing ratio.

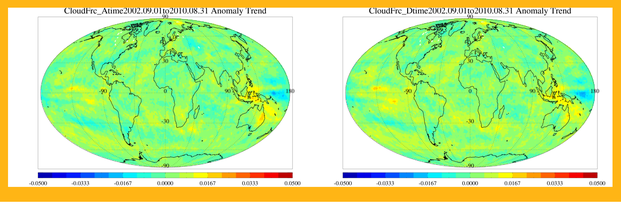
Ascending Descending



Effective Cloud Fraction

The Effective Cloud Fraction does not show significant trends.

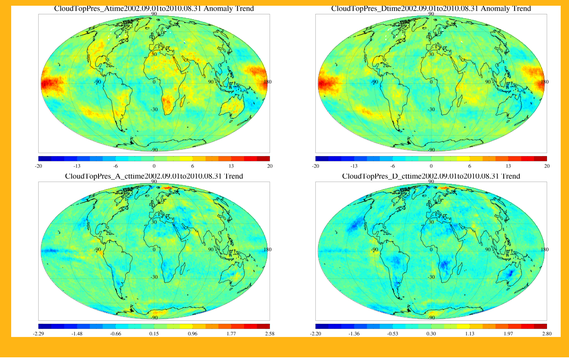
Ascending Descending



Cloud Top Pressure

The cloud top pressure resembles the changes in OLR seen in the tropical western pacific.

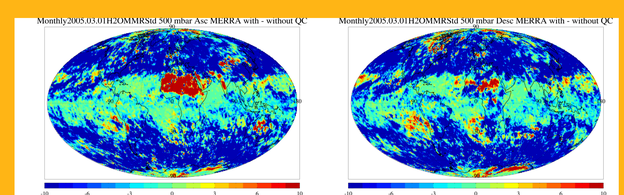
Ascending Descending



The Sampling Bias (A test case with MERRA)

We created monthly means of MERRA data sampled at (1) all of the locations where AIRS obtained a successful retrieval and (2) all of the locations where AIRS could have obtained a successful retrieval if it were omniscient. The difference between these two cases gives an estimate of the sampling bias that can exist in a climatology based on AIRS data.

Water Vapor sampling bias at 500 mbar for March 2005



Conclusions

- The AIRS data can explain the OLR trends by changes in water vapor and clouds
- Analysis of AIRS and MERRA data suggest there are small sampling biases but they are small and do not explain the observed trends.
- The AIRS climatologies shown here are available for analysis in Giovanni.